secured by very different means in two plants of the same genus, and so very much alike in all other particulars.

Hobart, July 25. HENRY J. COLBOURN.

Electricity direct from Coal.

WITH reference to the announcement made in the *Daily Mail* of September 1, that Thomas A. Edison had completed a machine for the generation of electric power direct from coal without the use of engines or dynamos, may I ask you to reprint a few lines from an article on electric traction I wrote for you, and which you published on April 12, 1894?

"Before electric traction can be employed on a very large scale, we must possess a means of producing the electricity on the spot and at the time it has to be used, or, in other words, we must possess a battery in which the energy of coal can be transformed directly into electric current, so that we may do without storage batteries in which to carry electric energy about, or heavy copper conductors through which to convey it at moderately low tension from the spot where it is produced to where it is used, or light aërial conductors through which to convey it at high tension.

"How long we shall be without this, or how many minds are engaged in the solution of this or some such problem, we know not, but the moment it is solved, and solved doubtless it will be, there will be such a transformation scene in the industrial applications of electricity as one can hardly conceive. It would mean that for almost all purposes except those in which heating is required electricity would or could be used. An electric light-producing battery in every house, quite independently of any mains in the streets; an electric power-producing battery to carry us whither we would on rails or on the streets; and in every house to put an end to all the evils attendant on crowded factories and workshops, in crowded streets and towns; such and other advantages would result from turning electricity from a servant into a master, from a mere transformer of energy into a source of energy."

E. F. BAMBER.

48 St. James's Square, W., September 3.

Artificial Deformations of Heads, and some Customs connected with Polyandry.

WITH reference to your note on M. Charles de Ujfalvy's recent article in *l'Anthropologie* (p. 323, *ante*), I may be allowed to call your attention to the ancient Korean practice of artificially deforming their heads, which was apparently similar to the method adopted by the Huns as well as the Hûna kings of India. Thus, the Chinese "History of the Later Han Dynasty," written in the fifth century, *sub.* "Eastern Barbarians," says: "The people of Ma-Kan (in the south-western part of the Korean peninsula) wish their heads flat; so the head of every child just born they compress with stone to deform it."

The special horned head-dresses worn by the polyandric women of the White Huns put in mind the old Japanese usages, described by Fujioka and Hirade in their "History of the Japanese Customs and Manners," Tokio, 1897, vol. i. p. 169: "In the festival of the god of Tsukuma, every woman had to go in procession after the holy sedan-chair, with a number of pans on her head proportionate to her immoralities. In the temple of Usaka, while the priest was praying in a feast-day, every woman was scourged on similar principles."

KUMAGUSU MINAKATA.

1 Crescent Place, South Kensington, August 11.

Huxley and his Work.

ON p. 13 of "One Hundred and One Great Writers," issued by the *Standard*, and presumably edited by Dr. Garnett, occurs the following remarkable account of Huxley and his work. "Huxley's work is that of the populariser, *the man who makes few original contributions to science or thought*, but states the discoveries of others better than they could have stated them themselves." Comment is needless. F. W. HENKEL.

Markree Observatory, Collooney, Ireland, August 23.

THE CAUSES OF FRACTURE OF STEEL RAILS.

WHEN the down Scotch express was running through St. Neots station, on the Great Northern Railway, on December 10, 1895, a rail broke into seventeen pieces, part of the train left the metals, and a serious accident resulted. Several features of the report on the mishap, drawn up in the ordinary course by the late Sir Francis Marindin, might well have occasioned deep thought, notably the conclusion that the first fracture of the rail took place over a chair at a minute induced flaw, which did not exist when the rail was manufactured.

The whole report, however, is suggestive rather than explanatory, and the result was the appointment by the Board of Trade of a committee to investigate the question of the loss of strength of steel rails caused by prolonged use. The committee was a very strong one, and contained some distinguished steel manufacturers, engineers, metallurgists and chemists. They collected a vast amount of information, much of it apparently considered unsuitable for publication, and made long series of experiments, many of them, judging from the report, more easily made than their results explained.

Finally, after four years' work, they have issued a report with the satisfactory feature that practically no change is recommended to be made in the mode of management of the permanent way by the railway companies.

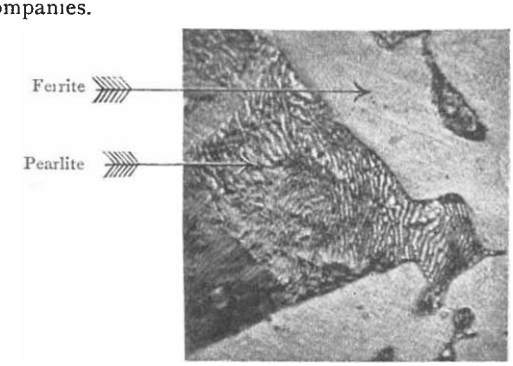

FIG. 1.—Steel rail. × 850 D. Showing pearlite and ferrite.

Nevertheless, although no legislation seems likely to result from the labours of the committee, the evidence that has been collected and published in the appendices to the report is of great scientific interest. The experimental work that was undertaken was divided among the members of the committee. A number of rails found broken on the road, or discarded as worn out, were selected for examination. Prof. Unwin took charge of the tests on their hardness, tensile strength and bending strain, and Mr. Windsor Richards of those on their resistance to the shock of falling weights; Sir William Roberts-Austen made micrographical examination of the rails, and Dr. Thorpe analysed them. Sir Lothian Bell includes in his comprehensive memorandum details of a number of mechanical tests on rails, and Prof. Dunstan gives an interesting account of the effects of atmospheric corrosion.

Interest naturally centred around the St. Neots rail. It was found to be of ordinary composition, and the mechanical tests applied to it showed that the steel was of variable, but, on the whole, of good quality. It was only on microscopic examination that the extraordinary character of the rail became evident. Good rail steel, according to Sir W. Roberts-Austen, consists of "ferrite," or iron free from carbon, and "pearlite," which is a mixture of alternate bands of ferrite and "cementite" (the carbide corresponding to the formula Fe_3C). The structure is shown in Fig. 1, a reproduction of a micro-

graph of rail steel magnified 850 diameters, in which the light constituent is ferrite, and the alternate bands of ferrite and cementite together make up the constituent pearlite. Well-developed pearlite with a conspicuous banded structure is characteristic of good rail steel. It is the form of carbide produced by slow cooling. When, however, steel is hardened by "quenching," pearlite is no longer to be found, and the whole mass consists of interlacing crystalline fibres devoid of banded structure, and is called "martensite."

With regard to this, Sir William Roberts-Austen says: "The detection of martensite in a rail should at once cause it to be viewed with extreme suspicion, as showing that the rail is too hard locally to be safe in use." An examination of the running edge of the St. Neots rail (Fig. 2) showed that a surface layer of about 1/100th of an inch thick existed, in which the carbide was mainly in the form of martensite.

This surface layer forms the lighter upper part of the figure, while the darker portion below it shows the usual assemblage of pearlite and ferrite granules. The actual running edge is shown against the dark space at the top of the figure. Martensite was also found in small patches in some other worn and broken rails, but to a far less extent, the St. Neots rail being unique in this respect.

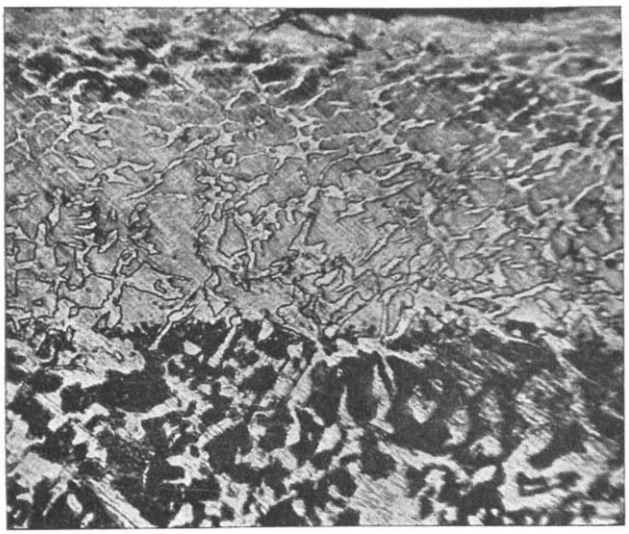

FIG. 2.—St. Neots rail, running edge. Pearlite passing into martensite. × 140 D.

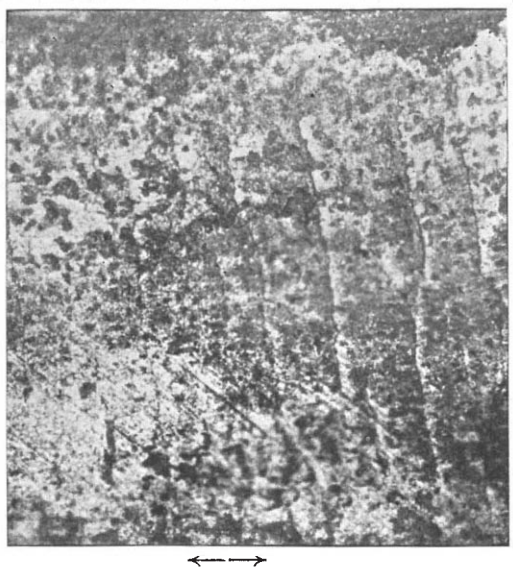

FIG. 3.—St. Neots rail, rolling surface. × 5 D.

The questions that naturally presented themselves on this discovery were, first, How far would this structure account for the brittleness of the rail? and secondly, How had the martensite been produced? With regard to the first question, the rolling surface of the St. Neots rail was found to be traversed by a number of transverse cracks (Fig. 3), some just passing through the hardened skin, others running into the substance of the rail. The upper surfaces of rails are subject to tension over chairs by the weight of passing trains applied between the chairs, and cracks are formed in this way. To realise the importance of these cracks, it is only necessary to turn to Mr. Martin's memorandum. He found that a heavy steel rail nicked with a chisel to a depth of 1/64th of an inch broke under the weight of six hundredweight let fall from a height of twelve feet, while the same rail, if not previously nicked, resisted successfully the fall of a ton weight from a height of twenty feet. The loss of strength due to these minute cracks is therefore amazing, and can only be accounted for on the hypothesis that shallow nicks are readily induced by shock to spread through the mass. The induced flaws of Sir Francis Marindin might thus be explained.

On the other hand, a warning note is struck by Prof. Unwin, who points out that minute transverse fissures are common on the rolling surfaces of old rails; and as only one rail in 2000 or 3000 breaks on the road, the others being discarded as worn out, it must be rare for such fissures to spread into the substance of the rail. It is suggested that if much silicon is present, the spreading of fissures becomes more rapid; but the St. Neots rail contained only 0·09 per cent. of silicon, an amount well within the limits of composition put forward by Messrs. Windsor Richards and Martin as suitable for rail steel.

On considering the problem of how martensite can be formed on the rolling surfaces, it is again evident that the St. Neots rail is a remarkable exception. All old rails become "hammer-hardened" on the surface by long use, and their strength and percentage of elongation may be increased by annealing, but no clear case of any production of martensite in this way could be obtained. The effect produced by the "cold-rolling" action of passing trains on steel is shown in Fig. 4, which is a photograph enlarged 140 diameters of the running edge of a rail taken up after ten years' wear. The direction of the granules is changed in the surface layer, but otherwise the structure is unaltered. Roberts-Austen succeeded in producing a structure like that of the St. Neots rail, but only by local heating with an electric arc. With regard to this, he observes that this experiment "points to the probability that local heating of a rail by skidding, followed as it would be by the rapid abstraction of the heat by the mass of the cold rail, can produce patches of martensite, though it may be very difficult in the laboratory to imitate the actual conditions by mechanical means." He seems to think that "the structure of the St. Neots rail would point to the changes having been effected while the rail was actually in use."

Although the St. Neots rail has thus baffled the committee, inasmuch as they cannot say definitely whether other rails are likely to be altered in the same way, it is evident that one of the most important results of their labours will prove to be the full realisation of the fact that steel possesses a complex structure which can be studied with the microscope, that this structure varies greatly with the mechanical and thermal treatment to

which it has been subjected, and that the durability of the rail depends on its structure.

Apart from the micrographical appendices, much interesting information may be obtained from a study of the mechanical tests, and some of the conclusions drawn by Prof. Unwin from these are among the most definite in the report, though they do not go far to explain the St. Neots mishap. It is found, for instance, that rails

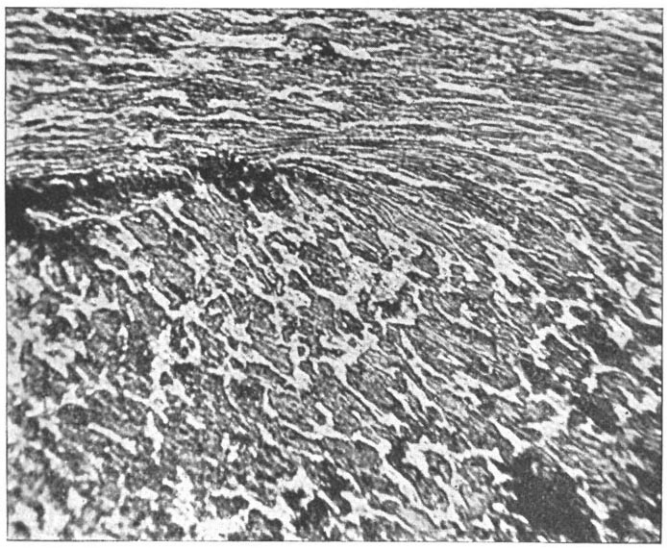

FIG. 4.—Running edge showing "flow." × 140 D.

generally break near their ends "owing to greater straining action due to discontinuity at the joint," and that the fish-joints are an unavoidable source of danger. It is also found that a rail is more liable to break when its worn head is turned down, as usually happens after a few years' use in the case of double-headed rails. Considerations of space alone prevent these points from being dealt with at greater length.

THE BRADFORD MEETING OF THE BRITISH ASSOCIATION.

THE final arrangements for the Bradford meeting of the British Association are now complete, and there is every indication that the gathering will be one of the largest that has been held in recent years. Representatives of scientific institutions are coming from nearly every country in the world; and there are delegates from the United States, Canada, the Cape, New Zealand, the West Indies, India, France, Germany, Russia, Denmark and Sweden, Spain, Italy and Greece. The Bradford people have come forward in a most willing manner to offer hospitality to the visitors, and a large proportion of the strangers will at any rate have had the opportunity of accepting private hospitality.

In our last article we dealt with the excursion programme. We propose now to say something about the various social functions which have been organised for the week.

The first social gathering will be a reception at the Municipal Technical College this afternoon (September 6). Mr. W. E. B. Priestley, the chairman of the Technical Instruction Committee, will welcome the visitors; and, after partaking of afternoon tea, they will be escorted in small bodies round the building, to see the textile exhibition, and the various processes of the textile industries. On the evening of the same day (Thursday) the Mayor and Mayoress have invited the Association to a conversazione in St. George's Hall. The building will be elaborately decorated, and music will be provided by a large string band, under the conductorship of Mr. I. Shepherd. There will be exhibits of various scientific novelties in different parts of the building; and the galleries will be specially levelled-up for refreshment and supper buffets. The 2nd West York Artillery Volunteers are providing a Guard of Honour to line the staircase.

At the conclusion of Prof. Gotch's lecture on Friday night there will be a smoking concert at the Technical College in honour of the President, for which various well-known elocutionists have been engaged.

On Monday, September 10, the Mayor and Corporation are inviting all persons attending the meeting to a large garden-party in Lister Park. The portion of the park where the guests will chiefly collect will be that above the lake. Around or in this space there will be several refreshment tents, and in front of each will be little tables in the open, surrounded by chairs, after the style of the foreign *cafés*. The lake will be decorated by means of Venetian masts and flags; while some new boats will be out, with boatmen in suitable garb in charge of them. The Black Dyke Band plays near the lake, and the band of the Bradford Rifles at the high end of the park. Archery and other amusements will be provided; and in one corner there will be some ballooning experiments under the direction of the Rev. J. M. Bacon, who is well known just now in connection with the trials which, in conjunction with Admiral Fremantle, he has been making in improved military signalling from balloons. Probably Mr. Bacon will be accompanied by the Admiral. It is proposed to erect a 70-foot pole about 30 yards from the balloon, and another, of equal height, in the furthest corner of the park; and, somewhere between the two, it will be attempted to explode a mine by means of wireless telegraphy, an experiment which was recently successfully performed at Newbury. Mr. Nevil Maskelyne will take part in the wireless telegraphic experiments, in order to exhibit the new receiver which he has patented and sold to Lloyd's.

On Tuesday the Mayor and Corporation are inviting the Association to a soirée in St. George's Hall. The arrangements will be somewhat similar to those on the occasion of the Mayor's function on the preceding Thursday, excepting that the music will be provided by the band of the Artillery Volunteers.

On Wednesday various private garden-parties will take place. Mrs. Henry Illingworth has invited 150 members of the Association to visit her grounds, for tea, tennis and croquet; and there will be music for those who prefer to rest after their labours. There will also be a garden-party at Ferniehurst, Baildon, by the kind invitation of Mr. and Mrs. G. C. Waud; a procession of prize-winning hackneys will take place in the course of the afternoon; and also sheep-dog trials, for which most of the celebrated dogs in the North Country have been brought together.

Messrs. Wm. Fison and Co. have also invited a hundred members to a garden-party at Greenholme, where, after tea, they will have an opportunity of visiting the turbine machinery and their textile works. Another function on the same day will be a garden-party at Royds Hall, by the kind invitation of the Low Moor Iron Company. The visitors will first be taken round the foundries to see some smelting work, and to examine some of the most striking parts of the machinery.

On the evening of Wednesday (the 12th) there will be